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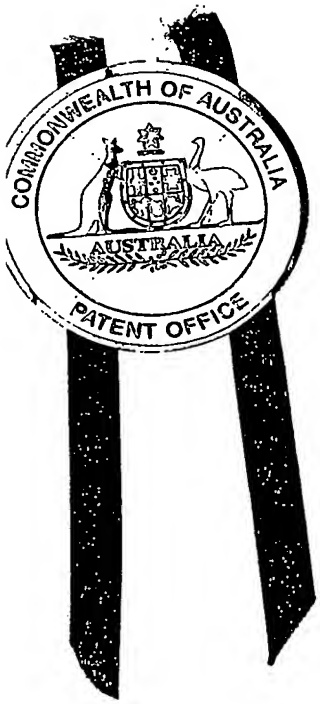

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First day of December 2004

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AUSTRALIA
Patents Act 1990
PROVISIONAL SPECIFICATION
FOR A PROVISIONAL PATENT

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Invention Title: **Further Improvements In Inline And Other Fasteners**

The following statement is a description of this invention

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This invention relates to improvements in inline and other fasteners. This invention is concerned, not necessarily exclusively, with fastener assemblies which can be useful for locks, latches, closures and the like.

The invention is at least partly based on the desire to provide a fastener assembly of sufficiently slim profile to be able to be concealed within elements having at least one narrow dimension, for example, having a thickness of between 15 and 20mm. The invention is intended to be particularly applicable to aircraft. Often in the description below reference will be made to this application. It is to be appreciated that the scope of the invention is not necessarily limited to this application, however.

In present aircraft design, most fasteners are designed to be hidden behind doors, panels, etc. It is common to include a manual release for a hidden fastener, whereby a tool can be inserted through a small aperture visible from the cabin side of the door, panel or the like. It is an object of this invention, at least in one embodiment, to provide a fastener assembly which can be manually released if desired.

In a first aspect, this invention provides a fastener assembly including:

an engagement means including latch means and locking means, the engagement means being movable between a locking position and an unlocking position;

biasing means urging the engagement means towards the locking position; and

means for drawing the engagement means from the locking position to the unlocking position, the drawing means comprising or including material adapted to contract when activated.

The fastener assembly of the invention is preferably capable of construction on a small scale so that, possibly with the exception of the engagement means, it has a cross sectional dimension of about 10mm. The purpose of this is so that the fastener assembly of the invention can be inserted into a panel, such as a panel for an aircraft which has a thickness of around 15 to 20mm. It is of course possible to provide the fastener assembly of the invention on a larger scale for other purposes.

The latch means and locking means of the engagement means may take any desirable configuration. An example is illustrated in the accompanying drawings. By way of non-limiting illustration, the latch means may include a pair of arms or jaws which can engage a latch, bar or projection. Other configurations will be apparent to one skilled in the art.

The locking means is preferably a slidable shuttle in which the latch means is generally received. In a preferred embodiment, the locking means has pair of arms adapted to embrace the latch means in the locking position and to hold the latch means in locking contact with the latch, bar or projection. In this embodiment, drawing of the shuttle away from the latch means is designed to allow the latch means to release contact with the latch, bar or projection.

The engagement means further preferably includes a pawl to facilitate rapid resetting of the fastener assembly after activation of the drawing means. In this embodiment, the fastener assembly of the invention can eliminate unnecessary delay between sequential unlocking and locking actions. It is also an option that this facility can be cancelled if rapid locking followed by unlocking is not desirable.

Preferably, the fastener assembly of the invention includes means for indicating the locked or unlocked states of the fastener assembly. By way of a non limiting example, this can be effected by micro switches in contact with the shuttle or an extension thereof. Information as to the locked or unlocked status of the fastener assembly can be conveyed to an indicator light or similar indicium locating in a convenient position.

The biasing means urging the engagement means towards the locking position is preferably a coiled spring, positioned in the fastener assembly of the invention so that the spring urges the engagement means, such as the shuttle, toward the locking position. When the means for drawing the engagement means from the locking position to the unlocking position is activated, this may cause compression of the spring, which accordingly can return the engagement means towards the locking position once the drawing means is no longer activated.

It is preferred that the fastener assembly of the invention includes additional biasing means, such as a spring attached to the pawl and a spring for ejecting the latch, bar or projection.

The drawings means itself consists of or includes material adapted to contract when activated. This material is preferably shape memory alloy wire. Shape memory alloys are known and are usually made predominantly or wholly of titanium and nickel. They may also include other material, such as aluminium, zinc and copper. A shape memory alloy is capable of adopting one shape below a predetermined transition temperature and changing to a second shape once its temperature exceeds the transition temperature. Conversely, when the shape memory alloy cools below the transition temperature, it is capable of adopting the first shape again.

Shape memory alloy wire currently available, such as that sold under the trade mark Nitinol, is capable of contracting by about 3 percent when activated by heating. Consequently, in order to provide sufficient "travel" in drawing the engagement means from the locking position to the unlocking position, the drawing means may include Nitinol wire in a single, relatively long or double line and a fastener assembly having this configuration may be referred to as an "inline" fastener assembly. This configuration enables the fastener assembly to have a slim profile, for the purpose of fitting into panels and similar elements, as referred to above.

In other applications, particularly where a slim profile is not a priority, or in those circumstances where a greater amount of "travel" is desirable, the Nitinol wire may be provided over a non-linear path. This may have the effect of permitting the fastener assembly of the invention to be provided in a more compact configuration compared to the inline fastener assembly referred to above. In addition, if, for example, the length of Nitinol wire in a non-linear path was around 200mm, the amount of contraction of Nitinol in its presently available form would be about 6mm. In a non-linear path, the Nitinol wire preferably loops over one or more spindles or rollers.

Activation of the material adapted to contract when activated is preferably achieved through electrical resistance heating, with a wire feed to the fastener assembly.

The fastener assembly of the invention may include many other options. One such option is the sensing of change in temperature, for example to indicate a dangerously high temperature, so that an appropriate alarm can be initiated, the fastener assembly of the invention being wired into, for example, the aircraft electrical system. Other sensing functions may be incorporated in the fastener assembly of the invention.

The fastener assembly of the invention may include multiple drawing means. This can provide redundancy, so that if activation of one drawing means fails to operate the assembly, the other or another of the drawing means can be activated.

The fastener assembly of the invention may be constructed in modular form. For instance, the engagement means may form one module, with the drawing means being located in a separate module. This allows interchangeability so as to permit different types of latch means to be exchanged in the fastener assembly of the invention, or to substitute, for example, a single drawing means with a multi-strand drawing means.

The fastener assembly of the invention is preferably enclosed in a housing which can be bonded or fitted into the panel, door or the like. This arrangement can assist in electromagnetic protection, can facilitate exchange of one fastener assembly with

another and can enable better adjustment of the fastener assembly within its surroundings. This can be particularly important if the fastener assembly of the invention includes facility for manual release as mentioned above. It can also permit the status (locked or unlocked) indicator to be visible from the same aperture which can be used for manual release.

The second aspect of this invention deals with protection of the drawing means from damage and applies not only to the fastener assembly of the present invention but to other applications in which a material adapted to contract when activated is required to pull on an element.

Material such as Nitinol is rated according to its composition. For example, a 330g Nitinol wire may have a pull force of 3.3 Newtons. If this wire is configured so as to pull on an element and the element is blocked from movement to a sufficient extent, the Nitinol wire may be capable of exerting a further pull force of, say, 9 Newtons. By this stage, however, the Nitinol wire may be in danger of being damaged. The invention in its second aspect has as an object the prevention or amelioration of such damage.

Accordingly, in the second aspect, this invention provides a strain reduction assembly including:

a material adapted to contract when activated, the material having:

a first pull force at which the material is adapted to move an element to which the material is directly or indirectly connected;

a second pull force greater than the first pull force; and

a third pull force intermediate the first pull force and the second pull force; and

means adapted to be activated when the pull force on the material has reached substantially the third pull force.

The means adapted to be activated when the pull force is substantially the third pull force may be a compression spring attached to the material.

The material adapted to contract when activated is preferably the Nitinol wire referred to above. The first, second and third pull forces will depend on the rating of the Nitinol wire. By way of example, if the rating is around 3.3 Newtons, this will represent the first pull force. The second pull force in this example will be around 9 Newtons while

the third pull force will be around 4.5 Newtons. Ideally, the third pull force is approximately one and a half times greater than the first pull force and calculated to be less than the second pull force, which may be calculated as that capable of causing damage to the material.

The element to be moved by the material adapted to contract such as the Nitinol wire may be any appropriate element. In the context of the present invention in the first aspect, the element is the engagement means. As stated above, the second aspect of the invention is not limited to the first aspect of the invention and consequently the invention in its second aspect has wide application.

The compression spring is preferably of any suitable construction.

The means adapted to be activated at the third pull force may take other forms. By way of non limiting example, the means may include monitoring resistance in the Nitinol wire and cutting of electrical power once the resistance has changed by, say, twenty percent.

In the case of either embodiment, the Nitinol wire can be protected from damage.

The invention will now be described in connection with a non-limiting embodiment illustrated in the accompanying drawings, in which:

Figure 1 is a side sectional view of an embodiment of the fastener assembly of the invention in the locked position, also illustrating an embodiment of the strain reduction assembly;

Figure 2 is a top sectional view of the assembly of Figure 1;

Figure 3 is an enlarged view of the left hand end of the assembly in Figure 1;

Figure 4 shows the assembly of Figure 3 as soon as the unlocking position has been attained;

Figure 5 shows the assembly of Figure 4 during cooling of the drawing means; and

Figure 6 shows the assembly of Figure 5, fully reset in the open position ready to move to the locking position and if required to unlock again immediately.

As shown in the Figures, fastener assembly 10 is contained within fastener mounting box 12 attached to an external power source through conduit 14. Fastener assembly 10

contained within box 12, is inserted into a panel (not shown) and secured in position by screws 16 attaching face plate 18 to flange 20 of fastener case 22, contained within box 12. Electrical connection via conduit 14 is continued into fastener case 22 by means of cable connector 26. Spring clip 28 is inserted beneath flange 20.

Fastener assembly 10 is intended to engage projection 24 (as shown in Figures 1 to 3), projection 24 protruding from a panel or door (not shown). In fastener assembly 10, the engaging means includes latch arms 30, shuttle 32 and pawl 34. Spring 36 biases shuttle 32 towards the locking position shown in Figure 1. Spring 40 urges ejector plug 42 towards the unlocked position. Shuttle 32 includes Teflon pad 44 to facilitate sliding of shuttle 32 within fastener case 22.

Fastener assembly 10 also includes shape memory alloy wire 46 which loops over pin 48 on pawl 34. Activation of wire 46 is controlled though printed circuit board sub assembly 50. Spring 38 is for urging shape memory alloy wire 46 to the locked position shown in Figure 1.

Sensor switches 52 contact extension 54 of shuttle 32 in order to provide an indication of the locked or unlocked status of fastener assembly 10. As shown in Figure 3, only one sensor switch 52 is in contact with extension 54 and assembly 10 can therefore indicate that the assembly is in the locked position. When both sensor switches 52 make contact with extension 54 as shown, for example, in Figure 6, the indication is that assembly 10 is in the unlocked state.

As shown in Figures 1 and 2, assembly 10 also includes spring 60 to relieve strain on shape memory alloy wire 46 should it be unable to draw pawl 34 away from the locking position.

Referring now to Figure 3, this shows fastener assembly 10 in the locked position. In this position, projection 56 on pawl 34 bears against pin 58 and ramp 62 engages shoulder 64 of shuttle 32.

Ends 66 of shuttle 32 bear against ends 68 of latch arms 30, ensuring engagement of ends 68 with recess 70 in projection 24 (see Figure 4).

When sufficient electrical energy is applied through the electrical connection via cable connector 26, wire 46 contracts, drawing pawl 34 away from the locking position, as shown in Figure 4. In this position, ramp 62 of pawl 34 has pushed against shoulder 64 until projection 56 has encountered travel limit pin 72, which has pivoted ramp 62 away from full contact with shoulder 64, as shown in Figure 4. At this stage, wire 46 is still

contracted. The withdrawal of shuttle 32 has moved ends 66 of shuttle 32 out of contact with ends 68 of latch arms 30. Latch arms 30 pivot around pivot points 74 and move out of engagement with recess 70 of projection 24. Ejector spring 40 pushing against ejector plug 42 has caused partial ejection of projection 24 from fastener assembly 10.

It will be appreciated that if travel limit pin 72 is removed, pawl 34 will pivot so that there is no contact with shoulder 64 at all. Shuttle 32 will then be free to move towards the locking position under the influence of spring 36. Projection 24 can then be engaged with fastener assembly 10. However, unlocking will not be possible until wire 46 has not cooled sufficiently.

In the next stage shown in Figure 5, projection 24 has been ejected completely from fastener assembly 10. Wire 46 has elongated to some extent while cooling and so pawl 34 has been able to move out of contact with pin 72.

In the configuration shown in Figure 6, wire 46 has completed elongation through cooling, pawl 34 has moved sufficiently away from pin 72 so that projection 56 has contacted pin 58, causing pawl 34 to pivot so that ramp 62 is in position to engage shoulder 64.

If projection 24 is pushed into fastener assembly 10 at this point, ejector plug 42 will be compressed against spring 40, ends 68 of latch arms 30 will snap into place into recess 70, ends 66 of shuttle 32 will be able to move into position against ends 68 of latch arms 30, spring 36 will move shuttle 32 to the left in Figure 6 and ramp 62 will engage shoulder 64 of shuttle 32, ready for unlocking if wire 46 is activated.

Aperture 76 though projection 24 is available for use as a light pipe - for example, for indication of locked or unlocked state. In addition, a suitable tool can be inserted though aperture 76, through an aperture (not shown) in ejector plug 42 and though gap 78 (see Figure 3) between latch arms 30. The tool can then exert pressure on shuttle 32 to manually move shuttle 32 towards the unlocked position, whereupon the contact between ends 66 and ends 68 will be removed, allowing ejection of projection 24 out of fastener assembly 10.

Reference was made above to the fastener assembly of the invention including sensors for temperature, for example. In Figure 1 these are shown at 80. Sensing is not limited to temperature sensing. As will be apparent to one skilled in the art, the fastener assembly of the invention can sense or control various other functions, such as lights, heaters, fans and so on. Thus the fastener assembly of the invention may have multiple

functions and may be involved in control of lighting, for example, control of lights within a compartment, the door of which is fastened by fastener assembly 10.

The embodiments shown in the drawings are mere examples of the fastener assembly of the invention. It will be apparent to one skilled in the art that many modifications and variations may be made to the embodiments described without departing from spirit or scope of the invention.

Dated this 13th day of August 2004

Telezygology Inc.

By its Patent Attorneys

Chrysiliou Law

FIGURE 1

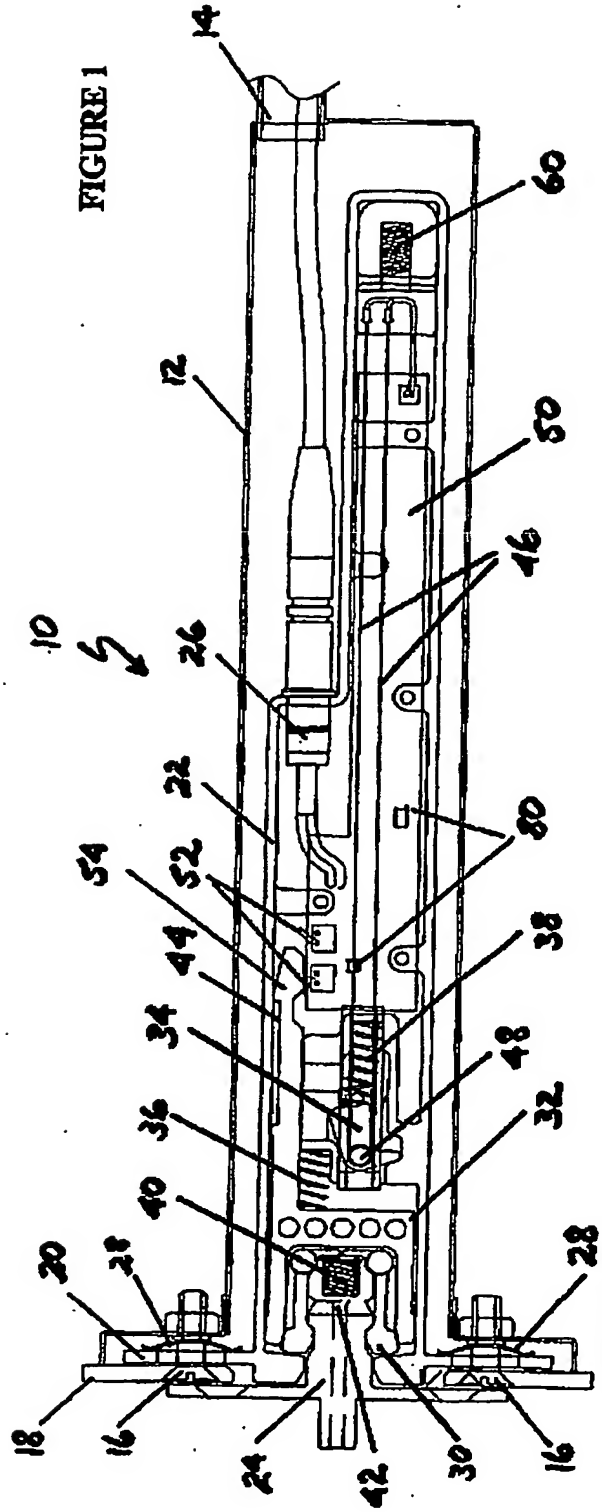
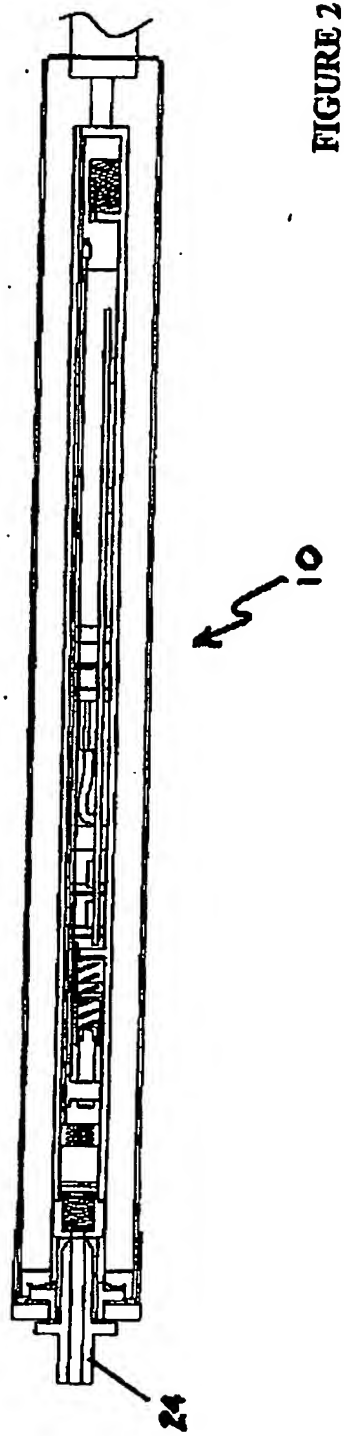


FIGURE 2



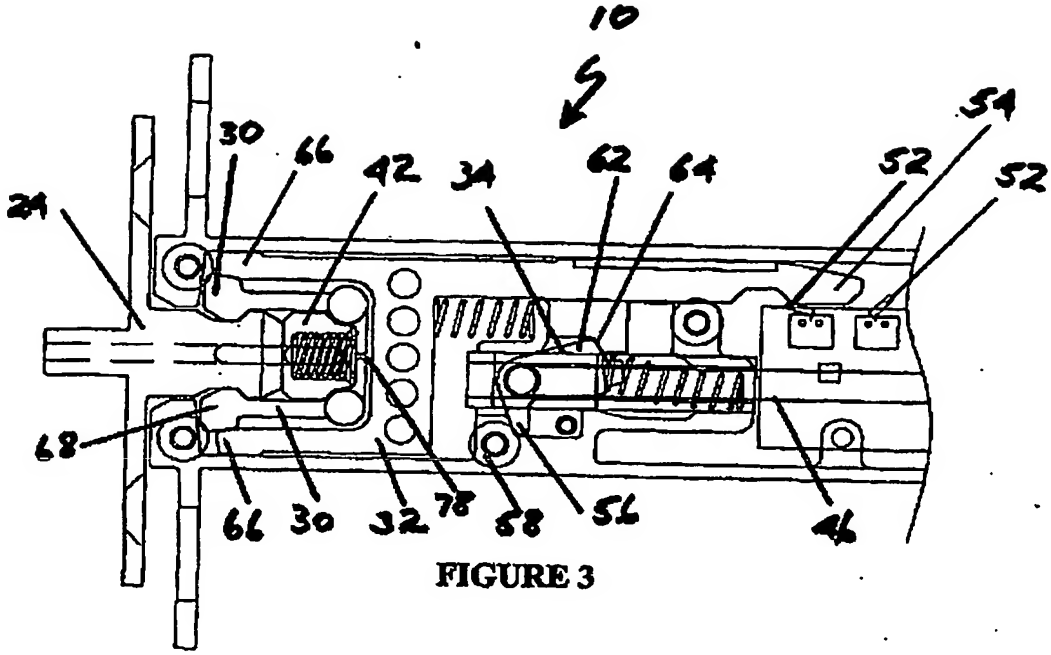


FIGURE 3

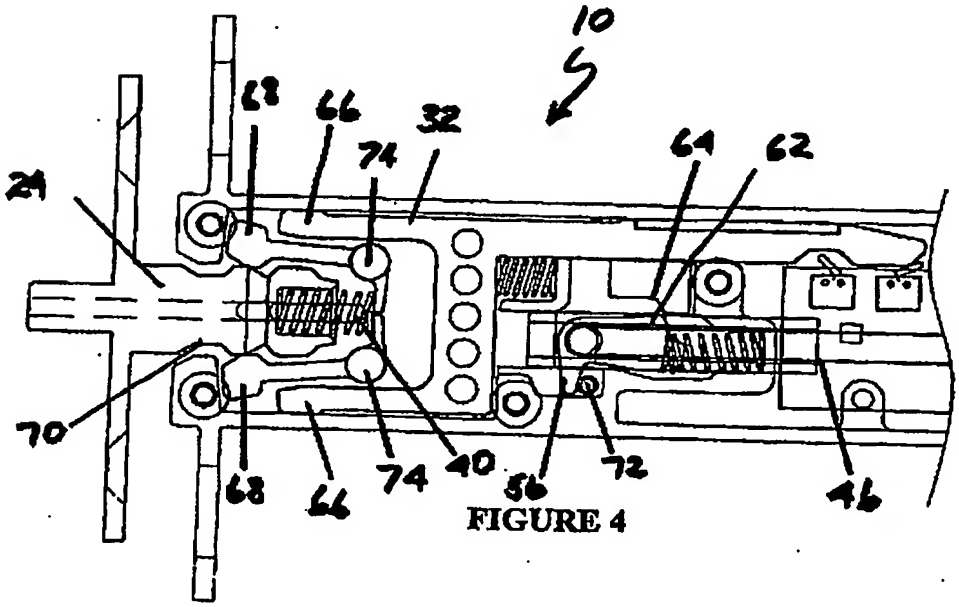


FIGURE 4

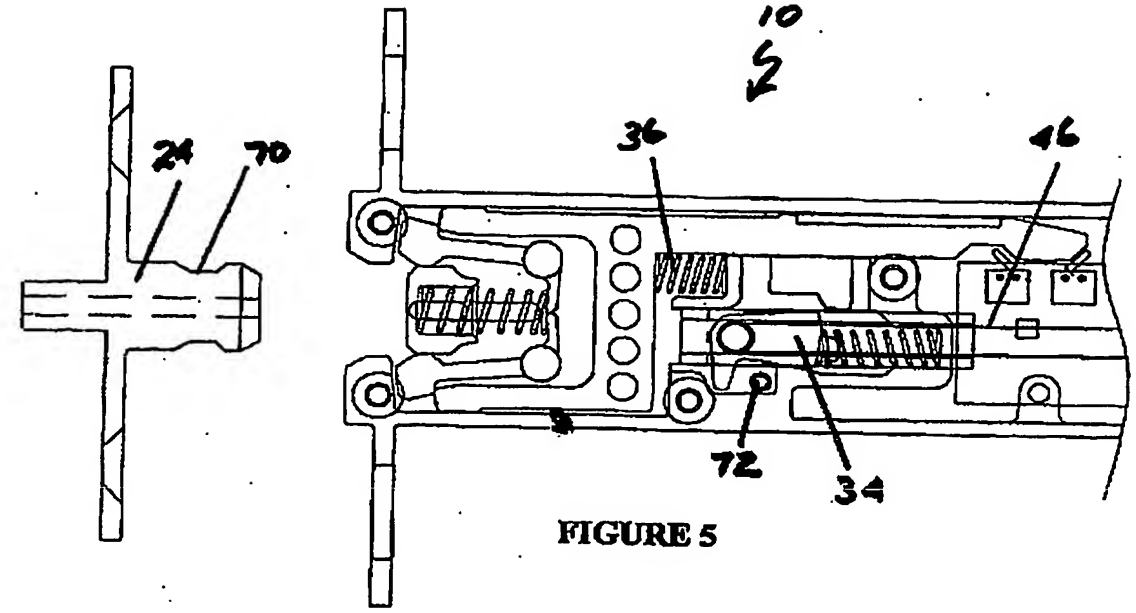


FIGURE 5

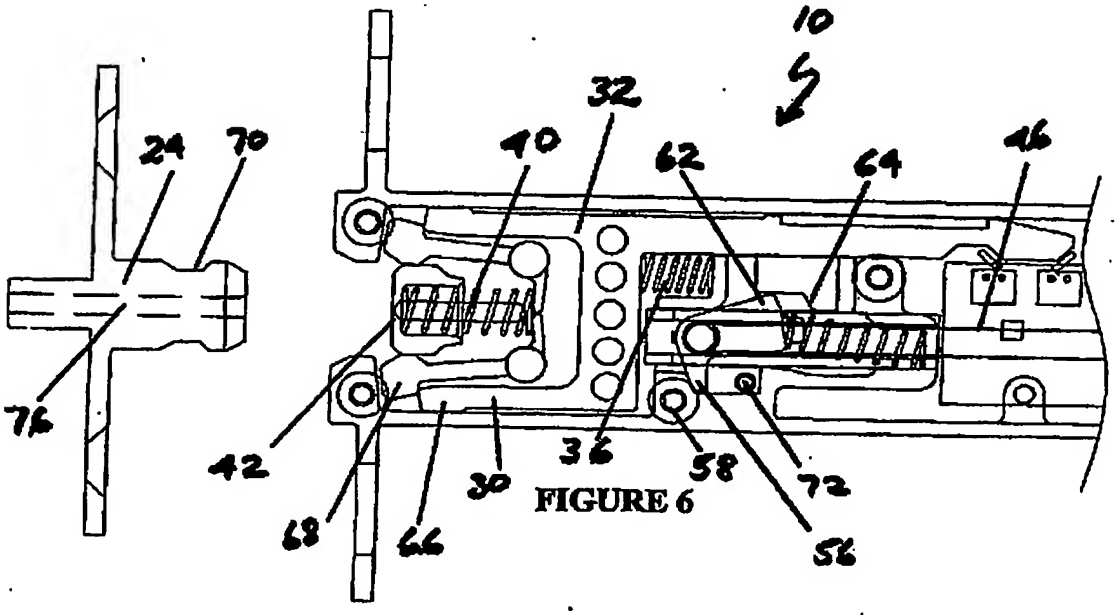


FIGURE 6

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/AU04/001580

International filing date: 17 November 2004 (17.11.2004)

Document type: Certified copy of priority document

Document details: Country/Office: AU
Number: 2004904582
Filing date: 13 August 2004 (13.08.2004)

Date of receipt at the International Bureau: 08 December 2004 (08.12.2004)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse